Use of of mechanical insufflation-exsufflation in neurological conditions: a UK national physiotherapy survey

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Use of mechanical insufflation-exsufflation in neurological conditions

a UK national physiotherapy survey

As neuromuscular disease progresses, altered chest wall mechanics, inflammation and infection, reduced airflow and decreased gaseous exchange results in a less effective cough, increased sputum retention, and difficulty in performing airway clearance to remove secretions (Botanio 2006, Panitich 2009). Effective airway clearance requires the mobilisation of secretions and an increase in lung volume prior to an effective cough (Finder 2006).

Weakness of the diaphragmatic, intercostal, inspiratory, expiratory and glottic muscles results in an inability to ventilate, decreased cough efficiency and, with bulbar muscle dysfunction, comes an increased risk of aspiration (Benditt *et al* 2006). Additional factors, which contribute to cough ineffectiveness and alveolar hypoventilation are: micro atelectasis; stiffening of the rib cage with loss of compliance; scoliosis or thoracic deformity; cardiomyopathy; obesity; fatigue; bronchial obstruction; sleep alterations (Servera *et al* 2006, Morrow *et al* 2013). This respiratory insufficiency is compounded as disease severity progresses and when there is an exacerbation due to a chest infection (Simonds 2007).

It is necessary to ensure adequate secretion management in the care pathway of patients at risk of developing respiratory compromise (Gauld 2009). The timely use of airway clearance, including either manual or mechanical cough augmentation techniques, should be incorporated into physiotherapy management, for people with neuromuscular disease resulting in respiratory compromise, in order to decrease hospital admissions due to respiratory problems, improve health-related quality of life and alleviate disability (BTS/ACPRC 2009, Bushby 2010).

A component of airway clearance, mechanical insufflation-exsufflation (MI-E), is a cough augmentation technique used by physiotherapists to manage people who present with an impaired cough (BTS/ACPRC 2009). Neuromuscular clinical guidelines from around the world state that the use of MI-E is based on moderate to low level evidence (ATS Respiratory Care of the Patient with Duchenne Muscular Dystrophy 2004, Motor Neurone Disease Association 2006, Consensus Statement for Standard of Care in Spinal Muscular Atrophy 2007, Bushby *et al* 2010, ACI Respiratory Network 2010, Consensus Statement for Standard of Care for Congenital Muscular Dystrophies 2010, BTS 2012). Previously, a single question posted on an interactive discussion forum for members of the Chartered Society of Physiotherapy established that approximately 64 healthcare organisations use MI-E in the United Kingdom (Chatwin, 2010).

In order to understand and further explore the clinical utility of MI-E in the care package of patients with respiratory compromise, due to a neurological condition, it is necessary to establish existing practice. Determining the clinical decision-making process to choose MI-E as a treatment technique will help inform future guidelines and training in clinical practice. The aim of this study was to assess the usage of MI-E by physiotherapists managing neurological conditions in the UK. Specific objectives included establishing neuromuscular conditions in which physiotherapists use cough augmentation techniques including MI-E; why and how MI-E is used; the outcome measures used clinically to ascertain effectiveness and how knowledge is gained.

METHODS

A questionnaire was developed after a review of relevant literature and discussion with the multidisciplinary team. The questionnaire was piloted for content validity and test-retest reliability (n=6), and necessary changes were made: definitions were provided to aid understanding; order and wording were changed for clarity; space was provided for additional answers; and questions were added regarding the pneumotachograph as an outcome measure and where training occurred. Twenty-four questions were included

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in the final version to capture: cough augmentation techniques used; the clinical populations using MI-E; factors determining the decision to use MI-E machine parameters and outcome measures used clinically; and sources of training.

Questionnaires were sent to members of the Health and Care Professions Council registered chartered physiotherapists currently practising in the United Kingdom who were also members of a clinical interest group managing people with respiratory compromise due to an underlying neurological condition: Association of Chartered Physiotherapists Interested in Neurology (ACPIN) (n=1,739), the Association of Paediatric Chartered Physiotherapists interested in Respiratory Physiotherapy (APCP) (n=107) and the Association of Chartered Physiotherapists in Respiratory Care (ACPRC) (n=750) (Total n=2,596). The questionnaire was sent to each membership database using electronic (SurveyMonkey) or postal methods, as directed by their individual preference. Follow-up reminders were sent out to non-respondents. The survey took place between June and July 2011. A favourable ethical opinion was provided by the Office for Research Ethics Committee in Northern Ireland (Ref: 11/NIR03/1).

STATISTICAL ANALYSIS

Closed categorical data was analysed descriptively using frequencies and percentages (IBM SPSS Statistics for Windows, Version 22). Open responses were quantitatively analysed using standardised content analysis and collapsed into categories with descriptive frequencies and percentages calculated (Stemler 2001; Krippendorff 2013). A p value of <0.05 was considered statistically significant.

RESULTS

A total of 2,596 questionnaires were administered of which 1,058 responses were returned, a response rate of 41%. A number of respondents were not eligible to reply: not currently practising; respondents responded to a yes/no question re MI-E use but did not consent to complete the full questionnaire, therefore, 912 completed responses were analysed.

A retrospective power calculation was carried out using a confidence level of 95%, a margin of error of 5% and a population size of 2,596. It was identified that a sample size of 335 would be required; therefore the actual 1,058 responses resulted in a margin of error of 2.3% which was deemed to be acceptable.

The majority of respondents worked in England (87%, 769/ 912) with a minority in Scotland (5%, 49/ 912); Wales (4%, 32/ 912) and Northern Ireland (4%, 34/ 912).

Cough augmentation techniques

The majority of respondents used the cough augmentation technique of suction (86%, 784/912) or manually assisted cough (81%, 736/912) and just over a third of respondents used air stacking either with: a self-inflating resuscitator (Ambu® bag) (39%, 351/912); intermittent positive pressure breathing (35%, 319/912); or non- invasive ventilation (32%, 287/912).

MI-E was used by half of respondents (48%, 479/1,002). Note the larger denominator is due to the 90 additional responses of those who completed a single question to determine if they used MI-E. MI-E was used primarily in those over 21 years (89%, 427/ 479) or in young adults from 16 – 20 years (43%, 207/ 479) and in children: 0–15 years (59%, 284/479). MI-E was used most frequently in the progressive neurological conditions of Motor Neurone Disease (57%, 272/ 479), Multiple Sclerosis (46%, 219/ 479) and Duchenne Muscular Dystrophy (45%, 216/ 479). MI-E was used in the respiratory management of spinal cord injury patients (61%, 291/ 479).

MI-E was most commonly used in the hospital environment (87%, 415/ 479); in the treatment of acute respiratory exacerbations (91%, 434/ 479); or as a prophylactic measure to prevent respiratory exacerbations (57%, 275/ 479). It was used less often at home (28%, 136/479). MI-E was used by patients who were spontaneously breathing (96%, 459/479). Patient's already prescribed non-invasive ventilation used MI-E as an adjunct to remove secretions (67%, 321/479). MI-E was less often used as an airway clearance adjunct by those patients who were mechanically ventilated (26%, 123/479).

Working parameters cited for cough augmentation

Optimal pressures of ± 40cmH20 are necessary to clear secretions (Philips Respironics 2014; ACI 2010; McKim 2011; BTS/ACPRC 2009). The number of physiotherapists using these parameters was: +40cmH20 (25%, 119/479) and -40cmH20 (33%, 158/ 479). The most common factor influencing choice of pressure was patient comfort and tolerability (78%, 373/479); failure to remove secretions (76%, 363/ 479); and pressures taught in training (67%, 323/ 479). Other factors which directed pressure settings were: restrictive thoracic mobility (59%, 283/ 479); size of thorax (48%, 232/ 479); reduced oxygen saturations (39%, 187/ 479); pressures already set (4%, 18/479); evidence (3%, 14/ 479); and co-existing conditions (1%, 5/ 479). A quality assurance mechanism exists in the form of local standard operating procedures in half of the clinical environments (49%, 236/479).

Outcome measures

Pulse oximetry (76%, 362/479); sputum production (71%, 339/479) and arterial blood gases (71%, 339/479) were the most commonly used physiological outcome measures to determine the effectiveness of MI-E and a smaller proportion of respondents used peak cough flow (28%, 135/479) and vital capacity (24%, 133/479). Half the respondents used the clinical measure of respiratory infection frequency (50%, 238/479). Patient reported outcome measures used

clinically include: quality of life (23%, 108/ 479); patient acceptability (39%, 188/ 479) and patient satisfaction (38%, 183/ 479).

Adverse events were reported by 20% (97/479) of respondents: change in heart rate; (61%, 59/97); change in blood pressure (53%, 51/97); thoracic soreness or chest wall pain (29%, 28/97); abdominal distention (26%, 25/97); vomiting (20%, 19/97); blood streaked sputum (10%, 18/97) or pneumothorax (9%, 9/97).

Factors influencing decision to use MI-E

For those respondents who use MI-E, the main factors which influenced their decision-making regarding its use in patient management were: access to the equipment (95%, 455/479); lack of training or competency (91%, 437/479); lack of evidence (79%, 377/479) or if other cough augmentation techniques were ineffective (90%, 432/479). Respondents using MI-E strongly agreed or agreed that MI-E is useful in assisting a cough in neurological conditions (74%, 355/479).

Training

Training almost exclusively occurred through in-service education (93%, 446/479) and advice from medical sales representatives (47%, 223/479). Training was less commonly received through postgraduate courses (21%, 98/479).

Respondents who do not use MI-E

Respondents who did not use MI-E (hence lower denominator) identified their barriers as: lack of training or competency (70%, 265/ 381); lack of medical or allied health profession staff advice regarding MI-E (58%, 219/ 381). Physiotherapists had difficulty either accessing MI-E equipment (55%, 210/ 381) or insufficient funding to support the cost of using MI-E equipment (31%, 117/ 381), while others were unaware of the existence of MI-E (50%, 191/ 381). A third of physiotherapists who did not use MI-E already felt they were using sufficient technique/s to augment a cough (33%, 127/ 381).

DISCUSSION

This study has identified that physiotherapists find MI-E useful in the management of impaired cough in a variety of neurological conditions. Physiotherapists need to incorporate existing evidence into their clinical practise and this study could assist in influencing further provision of MI-E in the UK and beyond.

There are a number of methods available for augmenting a cough and enabling secretion removal (Anderson *et al* 2005, Simonds 2007). In this study, suction was used extensively in clinical practice; however, this is an invasive procedure and it has been suggested that MI-E could remove the need for suction (Morrow *et al* 2013). Other established manual techniques which aid inspiration and expiration, such as air stacking and manually assisted cough, were also considered useful in clinical practice and further research comparing MI-E with other methods of augmenting a cough is required (Morrow *et al* 2013).

MI-E was the third most commonly used cough augmentation technique by physiotherapists managing a change in respiratory status due to muscle weakness and disease progression in those with progressive neurological disease. MI-E was extensively used within the spinal cord injury population to prevent respiratory complications which are the leading cause of morbidity and mortality in upper level spinal cord injury (Reid *et al* 2010).

Neuromuscular diseases can affect all ages and MI-E was used in both adult and paediatric neuromuscular population management. However, this study found less usage in those under 15 years despite the existence of guidelines and consensus statements advocating early introduction in order to accustomise children to treatment, prior to disease progression and medical emergencies (ATS 2004, SMA 2007).

Whilst usage was predominately in the hospital environment, for the management of respiratory exacerbations, there is some evidence of its use in patient management within primary care. This could have implications for service development within the multidisciplinary team as MI-E should be incorporated into the home environment to reduce unnecessary and costly hospital admissions and improve quality of life (MD Campaign 2011, Bento *et al* 2010). The majority of physiotherapists are using MI-E as a non-invasive adjunct in patients who are spontaneously breathing. It is also used in conjunction with non-invasive ventilation to enable optimal ventilation and secretion clearance identifying a role for both devices (ACI 2010, NICE 2010, Chen *et al* 2014). A clinical study supporting the introduction of MI-E as a weaning strategy to prevent re-intubation in those with acute respiratory failure (Goncalves *et al* 2012) is supported by this studies findings on the extended usage of MI-E in those who are intubated and ventilated in intensive care.

Evidence based practice reports that pressures of ±40 cmH2O need to be generated for effective airway clearance (Castro and Bach 2002, Goncalves and Winck 2008, Fauroux *et al* 2008, ACI 2010, Philips Respironics 2014). However, the results of this study demonstrate that this is not being achieved in clinical practice. The theoretical rationale, supporting physiological changes in airflow and volume using MI-E, needs to be utilised clinically and greater awareness of pressure requirements could be encouraged during training.

This study found that outcome measures used in clinical practice do not fully reflect the clinical guidelines strong recommendations of using peak cough flow and spirometry to monitor muscle weakness and direct the escalation of respiratory interventions (BTS/ACPRC 2009, ACI 2010, NICE 2010). Patient reported outcome measures which determine clinical efficacy such as frequency of respiratory infections and hospitalisations, duration of hospital stays and quality of life markers (Morrow *et al* 2013) were

less commonly used and are required in order to influence service development and assess the long-term effectiveness of MI-E usage.

As MI-E is delivering a pressure directly to the lungs it may adversely affect patients. A minority of respondents did identify events such as abdominal distention due to air being forced into the stomach. However, barotrauma resulting in a serious event such as pneumothorax was rare and correlates with existing evidence (Suri *et al* 2008).

Limited access to MI-E has affected its implementation within the patient care pathway and this needs addressing at a national as well as local level to enable optimal management in line with clinical guidelines. This study highlights the necessity to formalise training so that competency-driven training, with regular updates, is provided for physiotherapy staff.

In this study lack of evidence was identified as a reason for not using MI-E in clinical practice. There is moderate to low level short-term evidence and expert opinion to support use of MI-E in neuromuscular populations as reported in clinical guideline recommendations. However, long-term evaluation of MI-E as a component of the neuromuscular respiratory management of a patient's care package is necessary (Morrow *et al* 2013).

Limitations of this study

This study's findings are representative of physiotherapists who are members of neurological, respiratory and paediatric special interest groups who manage people with neuromuscular conditions. The response rate was low, even with robust methodological processes; however, the retrospective power calculation provides some assurance that the results are meaningful and have captured information which should be representative of the physiotherapy population studied.

CONCLUSION

Usage of MI-E by physiotherapists is established practice in the neuromuscular population. This study has identified gaps in service delivery and provided information that could be useful in informing education, training and service development.

At present clinical guidelines, based on moderate to low evidence, recommend the use of MI-E in those neurological populations with respiratory compromise. Until more robust evidence for the use of MIE in people with neuromuscular disease is provided, enabling fully informed decision making, MI-E usage should continue in line with clinical audit and evaluation. Physiotherapists need to implement recommendations in clinical guidelines to ensure the translation of existing evidence into clinical practice.

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